IS 8780 (2004): Non-Destructive Testing of Steel Castings - Code of Practice [MTD 21: Non-Destructive Testing]

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इस्पात ढलाइयों के अविनाशी परीक्षण हेतु — रीति संहिता

(पहला पुनरीक्षण)

Indian Standard

NON-DESTRUCTIVE TESTING OF STEEL CASTINGS — CODE OF PRACTICE

(First Revision)

ICS 77.040.20

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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Price Group 3

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Non-destructive Testing Sectional Committee had been approved by the Metallurgical Engineering Division Council.

The standard was first published in 1978 while reviewing this standard in the light of experience gained during these years. The Committee felt to revise this standard, while revising this standard following modifications have been made:

a) Scope has been modified.

b) Reference clause has been incorporated in this revision.

c) Clause for safety precaution has been introduced for the personnel who are involved in the radiographic testing. For this purpose, reference shall be made to the following Atomic Energy Regulatory Board (AERB) guides:

   1) SG/IN-1 Radiological safety in enclosed radiography installation, and

   2) SG/IN-2 Radiological safety in open field radiography.

d) Clause for personnel requirements has been incorporated.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

NON-DESTRUCTIVE TESTING OF STEEL CASTINGS — CODE OF PRACTICE

(First Revision)

1 SCOPE

This standard describes requirements and methods for non-destructive testing of steel castings. These non-destructive testing methods are intended to detect surface and internal discontinuities in castings. They include visual testing, magnetic particle testing, liquid penetrant testing, radiographic testing and ultrasonic testing.

2 REFERENCES

The following standards contain provisions which through reference in this text, constitute provision of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
2417 : 2003	Glossary of terms relating to ultrasonic testing (*second revision*)
2478 : 1991	Glossary of terms relating to industrial radiography (*second revision*)
2595 : 1978	Code of practice for radiographic testing (*first revision*)
2953 : 1985	Glossary of terms used for interpretation of welds and castings radiographs (*first revision*)
3415 : 1998	Glossary of terms used in magnetic particle flaw detection (*second revision*)
3657 : 1978	Radiographic image quality indicators (*first revision*)
3658 : 1999	Code of practice for liquid penetrant flaw detection (*second revision*)
3703 : 1980	Code of practice for magnetic particle flow detection (*first revision*)
7666 : 1988	Ultrasonic examination of ferritic castings of carbon and low alloy steel — Recommended procedure (*first revision*)
13805 : 2004	General standard for qualification and certification of NDT personnel

3 TERMINOLOGY

For the purpose of this standard, the definitions given in IS 2417, IS 2478, IS 2953 and IS 3415 shall apply, in addition to the following.

3.1 Defect — A flaw (imperfection or unintentional discontinuity) of such size, orientation, location or properties as to be rejectable.

3.2 Discontinuity — A lack of continuity of cohesion, an interruption in the normal physical structure of material or a product.

3.3 Flaw — An imperfection or unintentional discontinuity which is detectable by a non-destructive testing.

3.4 Imperfection — A condition of being imperfect, a departure of a quality characteristic from its intended condition.

3.5 Indication — The response or evidence from the application of a non-destructive testing.

4 SAFETY PRECAUTIONS

4.1 Methods used may involve hazardous materials, operations and equipment. It is the responsibility of the user of this standard to establish appropriate health and safety precautions.

4.2 When performing radiography with X-rays or gamma rays adequate precautions are taken to protect the radiographer and other personnel in the vicinity. For details about radiation protection, reference may be made to Atomic Energy Regulatory Board SG/IN-1 and Atomic Energy Regulatory Board SG/IN-2.

5 PERSONNEL REQUIREMENTS

Personnel performing non-destructive testing and evaluation shall be qualified in respective methods and for appropriate levels in accordance with the requirements of IS 13805 or any other equivalent certification schemes.

6 APPLICABLE TEST METHODS

All castings shall be subjected to visual examination at various stages of manufacture to detect any surface defect. In addition to this any one or more of the following method(s) as applicable may be carried out with the mutual agreement between the purchaser and the manufacturer.

6.1 Magnetic Particle Testing

This is a surface and subsurface flaw detection method which may be used for ferromagnetic steel castings.

6.2 Liquid Penetrant Testing

This is a method for detection of flaws open to surface and can be applied on all types of castings.

6.3 Radiographic Testing

This method may be applied to steel castings for detection of surface and internal flaws and has the advantage of being able to provide a permanent record on films.

6.4 Ultrasonic Testing

This method is generally applied for steel castings of suitable shape and sizes for the detection of internal flaws and has the advantage that it may be applied to large thickness of material.

7 VISUAL EXAMINATION

7.1 Introduction

This section deals with the visual examination of all types of steel castings. Surface testing shall be carried out at specific stages during the processing of the castings.

7.2 Equipment and Procedure

7.2.1 *Direct Visual Testing*

Direct visual examination may usually be made when access is sufficient to place the eye within 60 cm of the surface to be examined and at an angle not less than 30° to the surface to be examined. Mirror may be used to improve the angle of vision and aids such as a magnifying lens may be used to assist testing. The illumination on the surface is required to be not less than 500 lux.

7.2.2 *Remote Visual Examination*

Remote visual examination may use visual aids such as mirrors, telescopes, borescope, fiberscope, videoscope or other suitable instruments and shall have a resolution capability at least equivalent to that of direct observation.

7.3 Stage of Examination

7.3.1 *Examination of Cast Components*

Initial testing shall be carried out after the casting has been fettled and cleaned.

7.3.2 *Examination after Defect Removal and Weld Repair*

Visual examination shall be carried out after defect removal to make sure that previously revealed defect is removed completely. The final examination shall be carried out after completion of welding and preferably after heat treatment, if any.

7.4 Evaluation

All results shall be evaluated in terms of relevant acceptance standard.

7.5 Documentation

The date of examination, the examination procedure used and results shall be documented and certified. The illuminators, instruments, tools, equipments, etc, used shall be identified in the report.

8 MAGNETIC PARTICLE TESTING

8.1 Introduction

This section deals with the magnetic particle testing method of surface/sub surface flaw detection in the ferromagnetic steel castings. Finely divided magnetic particles are applied to the surface of the castings which has been suitably magnetized. The particles are attached to regions of magnetic flux leakage associated with defects and discontinuities, thus producing indications which are observed visually. The magnetic particles are applied either as dry powder or in a wet suspension in liquid medium. The testing shall be carried out as per IS 3703.

8.2 Surface Preparation

8.2.1 In general, satisfactory results may be obtained when the surface is in as cast condition, free from sand and dirt. However, in some cases, surface preparation by grinding or machining may be necessary when surface irregularities would otherwise mask the indication from discontinuities. All sharp edges and corners shall be ground to smooth curved surface.

8.2.2 If magnetic particles do not give good contrast on the casting surface, a thin coating of white paint may be applied to the surface under test.

8.3 Testing Procedure

8.3.1 The entire casting to be tested shall be magnetized and separately examined in two mutually perpendicular directions.

8.4 Non Relevant Indications

Non relevant indications are caused by distortion of magnetic field resulting from magnetic writing, cold working, hard and soft spots, boundaries of heat effected zone, abrupt change in section, etc. Care shall be taken to identify and eliminate them as they may mask the actual defect.

NOTE — Casting which exhibit significant residual magnetism should be demagnetized on completion of test when specified by the purchaser.

8.5 Evaluation

All the indications shall be evaluated with respect to the acceptance/rejection criteria for their relevency as a flaw, indications related to flaws shall be evaluated for the type and extent of flaw.

8.6 Documentation

Report for test carried out shall include area examined, magnetization technique, type of magnetic particles used and its application, value of magnetizing current, surface preparation, demagnetization details and results.

9 LIQUID PENETRANT TESTING

9.1 Introduction

This section deals with the liquid penetrant testing method of surface flaw detection of all types of steel castings. The liquid is applied to the clean and dry surface of casting to detect discontinuities, which are open to the surface. Sufficient time is allowed for the penetrant to remain on the surface during which it penetrates in all the discontinuities. Excess pentrant on the surface is removed without removing the penetrant, which gets entrapped into the discontinuities. A thin coat of developer, which acts as a blotter is then applied to the surface. The blotting action of developer draws the penetrant from the discontinuity and the penetrant appears as an indication on the surface (*see also* IS 3658).

9.2 Surface Preparation

In general, satisfactory results may be obtained when the surface is in as cast condition, in case of investment casting, centrifugal casting and die casting. In some cases, however, surface preparation by grinding or machining may be necessary when surface irregularities would otherwise mask the indications of discontinuities.

NOTE — Blasting with shot or dull sand, rotofinishing, buffing, wire brushing or machining with dull tools may be used with caution as they may block the discontinuities at the surface.

9.2.1 The surface to be tested and any adjacent area should be dry and free from any dirt, grease, lint, scale, oil or any extraneous matter that would obscure surface opening or otherwise interfere with the testing.

9.2.2 Typical cleaning agents which may be used are detergents, organic solvents, descaling solutions and paint removers.

9.3 Examination

It is a good practice to observe the surface during the application of the developer in order to detect the nature of certain indications which might tend to bleed out profusely. Final interpretation, however, shall be made after allowing the penetrant to bleed out for a period not less than the specified developing time.

9.4 Evaluation

Indications, if any, shall be evaluated for acceptance/ rejection, based on the applicable standards.

9.5 Post Cleaning

Casting shall be properly cleaned using a cleaning agent to remove any trace of developer/penetrant.

9.6 Documentation

Report of test carried out shall include type of penetrant, method, area examined and results.

10 RADIOGRAPHIC TESTING

10.1 Introduction

This section deals with radiographic testing of castings for discontinuities with the use of radiographic film as the recording medium and X-ray and/or gamma rays as source of radiation. Other fimless recording may also be used, with mutual agreement, provided the sensitivity levels are met. Radiographic testing shall be carried out as per IS 2595.

10.2 Surface Preparation

Castings should be fettled and loose scale and excessive roughness should be removed. Where local grinding is necessary, care should be taken to preserve the natural profile of the castings. A good as-cast surface is adequate.

10.3 Identification

Each section of the casting radiographed should have suitable symbols affixed to identify the casting and the area of the casting under testing. The lead letters or numerals should in general be placed on the surface facing the source of radiation. Where this is not possible, they may be placed on the film side of the casting.

10.4 Image Quality Indicators

In order to ascertain the quality of radiographs, image quality indicators (IQIs) shall be used as described below:

a) Any one or two types of IQIs described in IS 3657 may be used.

b) If the zone covered in radiography includes more than one section thicknesses, one IQI for every thickness shall be placed.

c) If the casting surface is smooth, the wire type IQI or step-hole type can be directly placed on the casting. If step-hole type IQI is employed, it shall be placed on a block of identical material, having same thickness as the area being radiographed. This block shall be kept directly on the film, just by the side of casting. This method shall be adopted, if the surface roughness of the casting is likely to interfere with the IQI image.

d) Unless specified otherwise, 2 percent sensitivity will be achieved, which has the following meaning:

   1) For step-hole type IQI, image of the step and the hole in the same step shall be seen. The step thickness shall be 2 percent of the section thickness being radiographed. If the Table 2 in IS 3657 does not have a step of required thickness, next higher step can be accepted.

   2) For wire type IQI, the wire diameter shall be 2 percent of the job thickness. If the Table 1 in IS 3657 does not have a wire of required diameter, next higher diameter can be accepted.

   3) For strip-hole IQI, the thickness of the strip shall be 2 percent of the job thickness. The hole shall be visible. If IQI of required thickness is not available, next higher step can be accepted.

10.5 Evaluation

Reference radiographs illustrating grades of various casting discontinuities shall be used to help establish acceptance criteria during interpretation of radiographs.

10.6 Documents

The following radiographic records shall be maintained as a minimum.

10.6.1 *Radiographic Standard Shooting Sketch*

10.6.2 *Documentation on Repair by Welding if Carried Out*

10.6.3 *Radiographs and/or Digitized Image in Case of Filmless Radiography*

10.6.4 *Interpretation Record*

11 ULTRASONIC FLAW DETECTION

11.1 Introduction

This section deals with the ultrasonic testing and wall thickness measurements of steel castings. Usually, normal beam technique is used for flaw detection in casting.

11.1.1 *Casting Condition*

Ultrasonic testing shall be carried out on the casting after grain refining heat treatment and prior to machining of those areas which could interfere with testing.

11.1.2 *Test Condition*

To assure complete coverage each pass of the search unit shall overlap by at least 10 percent of the width/ diameter of the transducer.

11.2 Testing Procedure

Ultrasonic testing of ferritic steel castings should be carried out in accordance with IS 7666.

11.2.1 *Selection of Testing Technique*

Selection of the testing technique depends upon the following factors:

a) Type, orientation, position and incidence of defects likely to be encountered in the casting under consideration;

b) Thickness and profile of the section; and

c) Metallurgical condition.

11.2.2 *Test Frequency*

For all ultrasonic examinations, the highest frequency compatible with the size, metallurgical condition and thickens of the casting should be used. Normally test frequencies in the range of 0.5 MHz to 2 MHz are adequate. However, the optimum frequency compatible with the size, metallurgical condition and thickness of the casting shall be used.

11.2.3 *Procedure*

All parts of the casting surface where a contact probe may be used, should be tested, irrespective of casting geometry of whether a back wall signal is obtained for use as a reference. A longitudinal wave probe of a frequency of 2 MHz should normally be used but should be augmented a necessary by angle beam. When examining areas which have to be machined, a double crystal probe should be used to

minimize dead zone problems. This type of probe should be used for the examination of thin sections. Where large areas have to be covered, a probe giving a beam of larger diameter should be used for an initial search for defects. A more critical examination of suspected area, if any, shall be made. It should be noted that crystals of each twin-crystal probe have their angle of incidence and so its own range of testing depth and dead-zone. An angle beam probe is useful when assessing defect size and type, for examination under difficult geometric conditions and for the detection of unfavorable oriented defects.

11.3 Wall Thickness Measurement

Using the pulse echo-technique longitudinal wave probes may be used for thickness measurement of casting by directly calibrating the time base scale against parallel surfaces of the same casting having a known thickness. For this application, the highest frequency compatible with the material under examination should be used. Using this procedure, the accuracy of the measurement shall be about 2 percent to 5 percent of the section thickness, but shall depend upon two main factors, that is the surface roughness and whether or not the surface are parallel.

11.4 Evaluation

The results of the test shall be evaluated with respect to the acceptance criteria, for their relevance as a flaw.

11.5 Documents

The manufacturer's report shall contain the examination frequency, type of instrument, reference block, type of search unit, couplant, location, size and echo amplitude of defects and a sketch showing the location of all indications and areas not inspected due to geometric configuration.

Bureau of Indian Standards

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Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards : Monthly Additions'.

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